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NRL Report 7692
Copy No. 85

**Madre Analysis of Observational Data
from the AN/FPS-95 System**
[Unclassified Title]

F. H. UTLEY, F. E. BOYD, C. M. HOWE,
G. A. SKAGGS, AND B. N. NAVID

*Radar Division
Radar Techniques Branch*

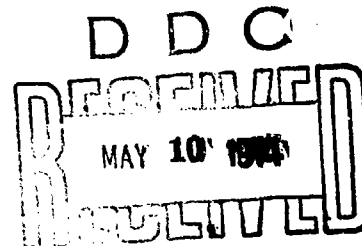
March 13, 1974

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) (S) NRL personnel experienced with analysis of madre radar data have commenced an in-depth analysis of the tape record from the FPS-95 radar for the observation of the Cosmos 478 earth satellite launch from the Plesetsk Range Head on 15 March 1972. (This analysis is sponsored by the Air Force Systems Command and the Electronic Systems Division under Pro- grams 441A and 414L.) Significant findings to date include detection of sustainer-engine- produced ionospheric perturbation, high-altitude preinsertion burn of the vernier engine (Venik), and insertion staging with reflections from multiple bodies at ranges in excess of 2000 n.mi.		

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20. Also of interest was the detection and tracking of three aircraft at two-hop ranges in excess of 2900 n.mi. This is an interim report; cross-section estimation and identification of insertion-staging elements is continuing.

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**MADRE ANALYSIS OF OBSERVATIONAL DATA
FROM THE AN/FPS-95 SYSTEM
[Unclassified Title]**

INTRODUCTION

(S) Over-the-horizon (OTH) radar has demonstrated its capabilities for the detection and tracking of missiles [1-8], aircraft [9-11], and ships [12-14] at ranges extending from approximately 500 to 2000 n.mi. These detections have been obtained by the propagation of high-frequency (HF) energy refracted from the ionosphere. Energy impinging upon the target is scattered in all directions. Part of the energy is propagated back to the radar site via the sky-wave refraction at the ionosphere. A skip zone of approximately 500 n.mi. from the radar site precludes detection of targets within this radius via use of sky-wave propagation. However high-frequency surface-wave propagation does permit target detection out to approximately 100 n.mi. from the radar site.

(C) A typical OTH radar radiates 100 to 600 kW of average power at frequencies in the 5-to-40-MHz band using antennas from 300 to 8000 feet long. Typical pulse repetition frequencies used are 10 to 200 Hz. Both monostatic and bistatic experimental radars have proven their detection capabilities. Both frequency-modulated continuous-wave (FMCW) and pulsed doppler techniques have been used in these radars.

(S) The FPS-95 OTH radar was designed for detecting and tracking aircraft and missiles over Warsaw Pact nations and western USSR. Located at Orfordness, England, the FPS-95 radar was designed to cover a 90° sector in the easterly direction. The more important parameters designed into this radar are listed in Table 1.

(S) The Naval Research Laboratory is supporting the U.S. Air Force in its FPS-95 radar program with engineers both at the radar site as well as at NRL. Recently NRL received an observation tape from the FPS-95 site for the launch of the Cosmos 478 earth satellite vehicle from the Plesetsk range head. NRL personnel at the FPS-95 site have provided pertinent information about the missile launch, flight trajectory, radar parameters used, and radar coverage areas [15]. The launch took place at 13:00 GMT on 15 March 1972. This tape (No. 513) has been subjected to preliminary analysis with the processor that was built for the Madre radar. Certain significant features of the missile flight have been discerned. Even though analysis is not yet complete, findings to date will be reported.

COSMOS 478 LAUNCH OBSERVATIONS

(S) The FPS-95 radar was activated on 26.500 MHz and a PRF of 40 pps for the viewing of the launch. The Plesetsk range head is approximately 1400 n.mi. from the

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Table 1
Characteristics of the AN/FPS-95 Radar

Parameter	Value
Frequency	6-40 MHz
Antenna type	2000 ft log periodic elements
Antenna beamwidth	7° azimuth (independent of frequency)
Antenna gain	23 to 25 dB
Antenna coverage	91° with 50 ms steering time per 7° step
Transmitter power	200 kW average, 5 MW peak
Pulse width	250 μ s to 6 ms
PRF	10, 40, 53, 80, or 160 Hz
Signal processor	60-dB dynamic range
Integration time	0.3, 1, 3, 10, or 20 s
Range accuracy	± 10 n.mi. or better
Azimuth accuracy	$\pm 2^\circ$ or better
Doppler resolution	0.1 Hz (2 knots at 15 MHz)

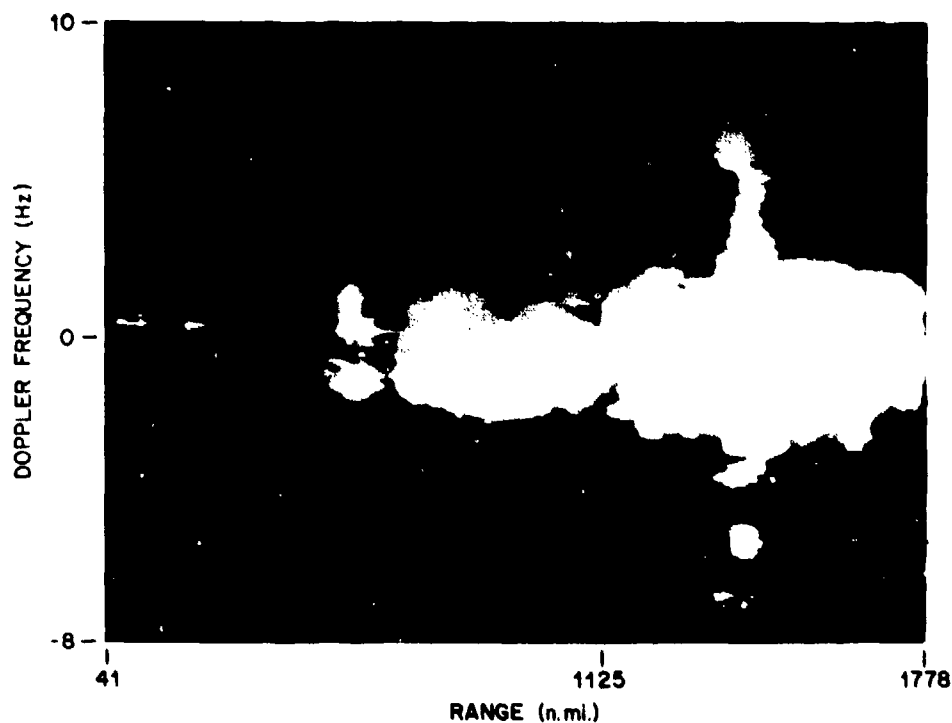


Fig. 1 — Offset doppler frequency versus range showing backscatter

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FPS-95 site. Backscatter obtained on the operating frequency commenced at 1125 n.mi. and extended to beyond 2000 n.mi. (first hop). Figure 1 is an offset-doppler-versus-range record showing the earth returns, which are ambiguous beyond 2000 n.mi. due to the 40-pps repetition rate. The range strobe position at 1125 n.mi. marks the leading edge of first-hop returns. The other scatter patterns in view at nearer ranges are due to additional refractions beyond the first.

(S) Figure 2 is a plot that identifies the range-ambiguous backscatter for echo level from each of the three hops normalized to the amplitude of the first-hop return. The azimuthal extent is computed on the basis of a 7° radar beamwidth. Figure 3 shows the three earth-return patterns in the correct (unambiguous) range relationship to each other.

(S) It is of interest to note the disposition of the first and second hop to each other. The missile launch occurred in the coverage of the first hop with subsequent flight, while under power, through the scatter-free region between 2000 and 2650 n.mi. The missile effects reported herein were all detected while the missile was passing through this region. In the latter portion of the report samples of aircraft detection via two-hop illumination are given.

Perturbation Echo

(S) Many of the early (1958-1960) detections made of Atlantic Missile Range launches with NRL's low-power Music radar consisted of perturbation echoes [16-19]. These echoes appear in the earth return at essentially twice the range to the missile when the missile under power passes through the refracting region of the ionosphere that is controlling the path to the more distant earth return. This echo is generated rather promptly with passage of the vehicle through the controlling refractive zone. Its onset is rather abrupt, and its demise is generally slower than the onset. The characteristic effect noted in the backscatter that has been influenced by a perturbation in the ionosphere is a shift of the doppler spectrum of the backscatter to recede dopplers.

(S) Figure 4 is a doppler-versus-time record of approximately 21 minutes during the Cosmos 478 launch showing the perturbation echo with commencement at 13:05:02. The doppler extent of the echo quickly expands to 20 Hz (maximum unambiguous doppler) and persists as a doppler-ambiguous signal for several minutes. The recovery of the echo to quiescent dopplers takes place at a slower rate than its onset. The noiselike signal in excess of 2 Hz in doppler is likely due to auroral or field-aligned echoes.

(S) Figure 5 is another plot of the video doppler behavior in Fig. 4. The rise time associated with onset carries the doppler to 20 Hz in approximately 1-1/2 minutes. The decay or recovery time is 5 minutes.

(S) NRL personnel at the FPS-95 site have detected the perturbation signal associated with this launch and have confirmed that its doppler excursion was to the recede side.

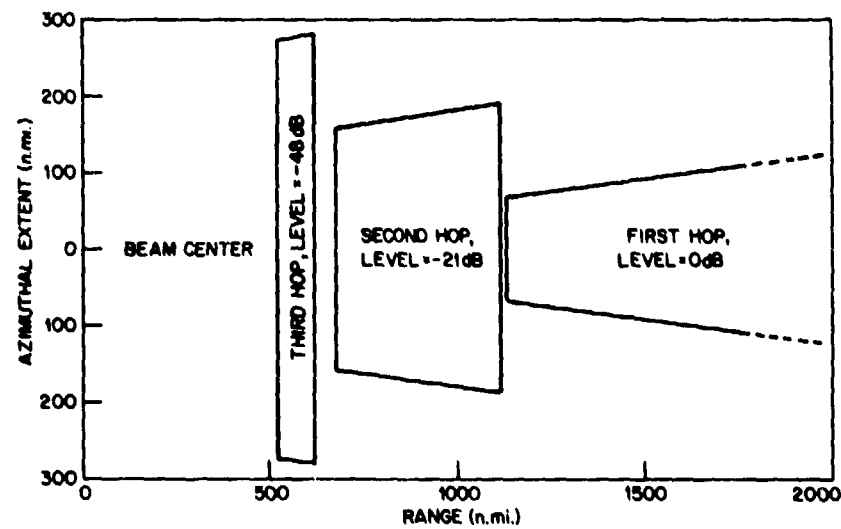


Fig. 2 - Range-ambiguous backscatter

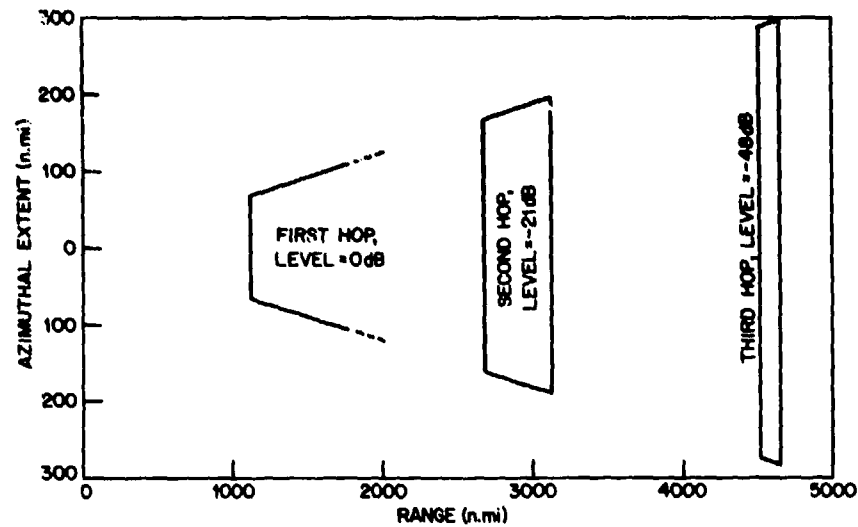


Fig. 3 - Range-unambiguous backscatter

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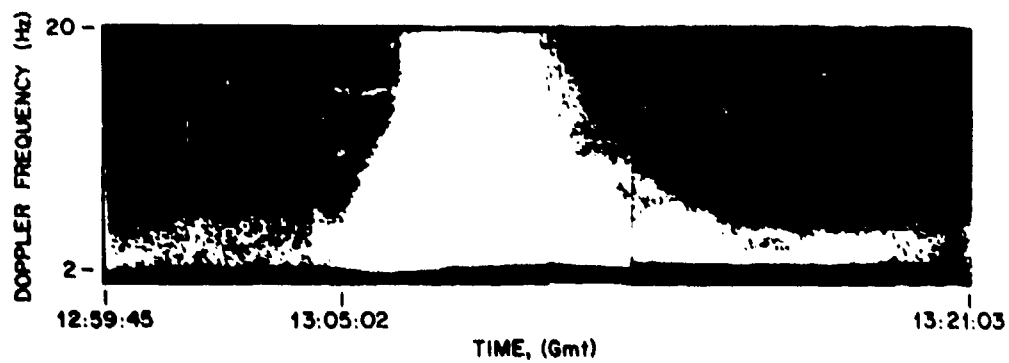


Fig. 4 — Sustainer-induced perturbation in the doppler-frequency-versus-time record

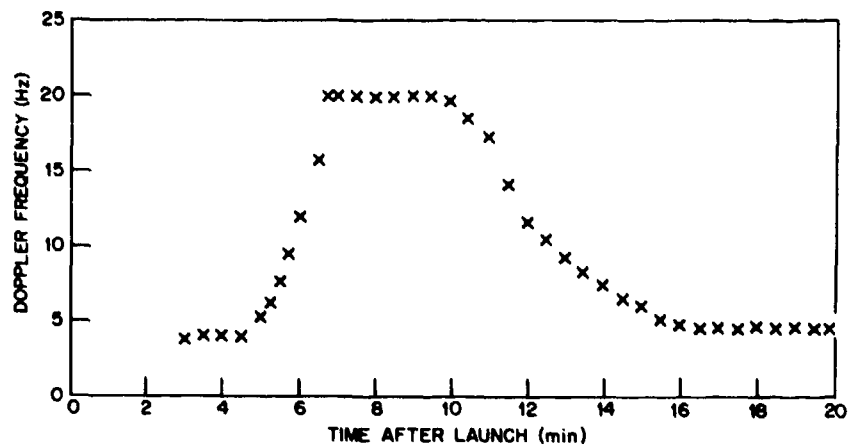


Fig. 5 — Plot of doppler frequency versus time after launch for the sustainer-induced perturbation shown in Fig. 4

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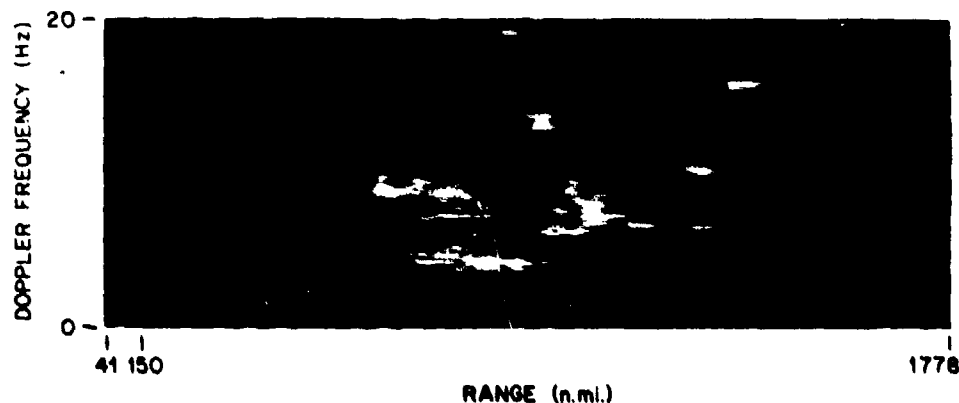


Fig. 6a - Doppler-versus-range record for 13:07:50 GMT

(S) Conservative estimates of cross section of the perturbation echo are 10^5 square meters.

(S) The perturbation echo was visible in the returns from the second-hop area. The Cosmos 478 sustainer engine was burning while the vehicle was passing through the ionospheric region controlling refraction to the region between 2670 and 3250 n.mi.

Vernier-Engine-Burn Echoes

(S) Figure 6a is a doppler-versus-range record for the time 13:07:50. There are three signal types of interest in the frame. Occupying the centermost portion of the record is a range-dispersive doppler-dispersive echo, which is the perturbation-signal structure. It extends in range from 600 to 1300 n.mi., which unambiguously corresponds to 2600 to 3300 n.mi., which in turn corresponds to the region of second-hop returns. So in this test observation the perturbation echo was produced in second-hop returns.

(S) To the right of the perturbation echo are echoes discrete both in range and in doppler. The echoes occurring from 1400 to 1700 n.mi. are doubtless aircraft echoes, with some of those coming from near 1400 n.mi. due to support flights for the Cosmos 478 launch.

(S) To the extreme left under the range strobe at 150 n.mi. (2150 n.mi.) is a range-discrete doppler-diffusive echo due to the burning vernier engine (Venik) of the Cosmos vehicle.

(S) Figure 6b is also a doppler-versus-range readout for the time 13:08:30. The FPS-95 radar calibration signal is under the doppler strobe near the left edge. The perturbation echo as well as a couple of aircraft echoes are also in view. At the left at greater

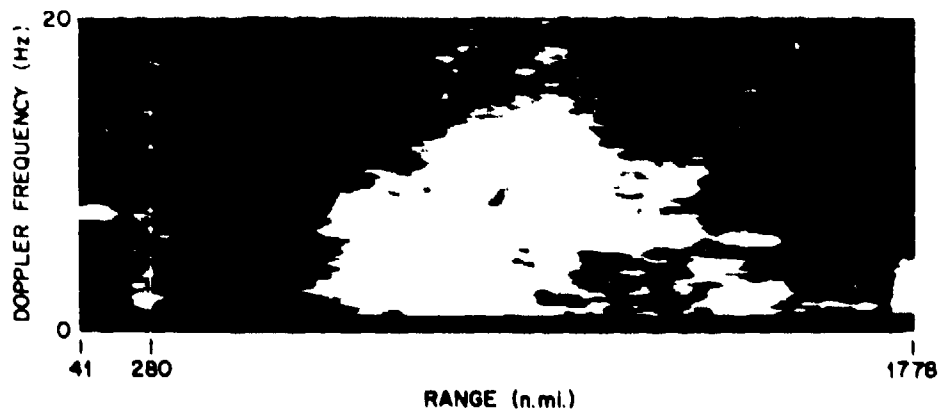


Fig. 6b — Doppler-versus-range record for 13:08:30 GMT

range than the calibration signal is a range-discrete echo under the range strobe at 280 n.mi. (2280 n.mi.). The doppler of this echo appears to be periodic. This echo occurred after vernier-engine shutdown (13:08:22). It is tentatively believed that the echo may be due to scattering that takes place at insertion staging or shortly thereafter. Work is continuing to determine the mechanism.

(S) Figure 7 shows the doppler-versus-time readout for two range-gate positions as indicated. The records are 248 seconds long. The vernier-engine-burn signal can be seen in both range windows but at dissimilar times. The time delay for the signature to appear in the upper frame is a function of the vehicle velocity due to the 40 n.mi. separation in the window opening. The vehicle-velocity line is subdued in the larger burn echo.

(S) Figure 8 is a plot of range versus time for the burning vernier stage as extracted from 5-second readouts of the doppler-versus-range display. That the vehicle was under going acceleration is apparent from Table 2, which shows velocity estimates extracted from the doppler-versus-range data.

(S) The anomaly that occurred at 13:08:00 to 13:08:06 (a decrease in velocity) was in all probability due to a multipath-type error that caused the missile to appear in a wrong range. The error seemed to correct itself by 13:08:10. The curve continues to increase monotonically until vernier-engine shutdown.

Insertion-Staging Echoes

(S) Figure 9 shows a double doppler-versus-time record with 80-n.mi. windows being initiated sequentially at 2280 and 2300 n.mi. The record begins at 13:06:11 and terminates 248 seconds later. The echoes from flanges, baffles, shields, or whatever may be released at insertion staging are very weak. Due to their high radial velocity (4 to 5 n.mi. per second) the echoes do not persist longer in a given range window than

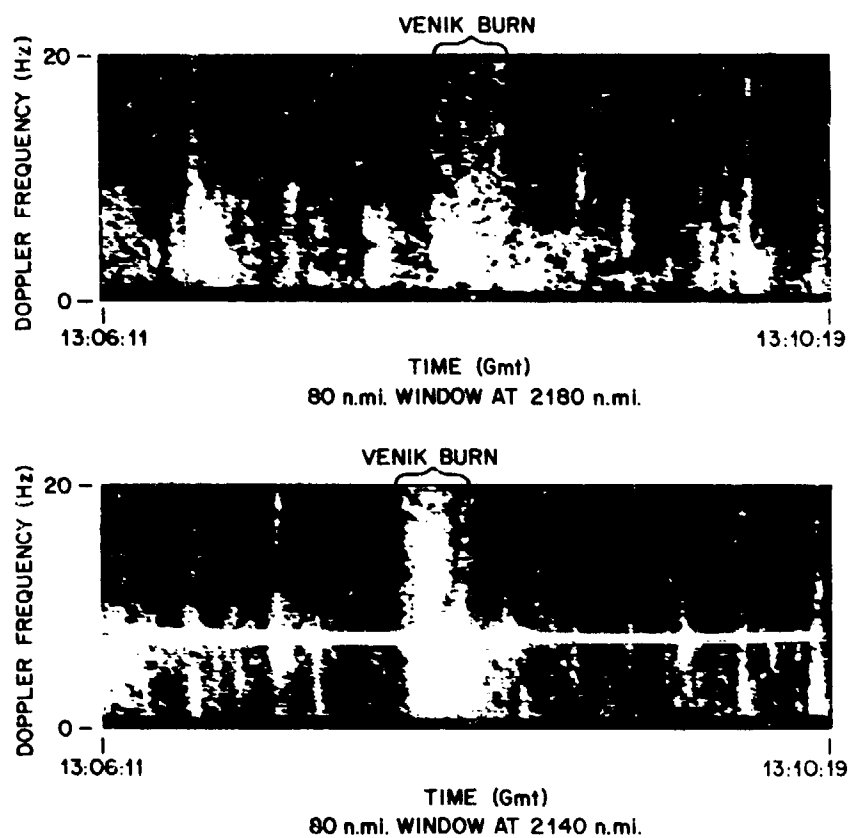


Fig. 7 — Doppler-versus-time record showing the Vernik burn for two range-gate positions

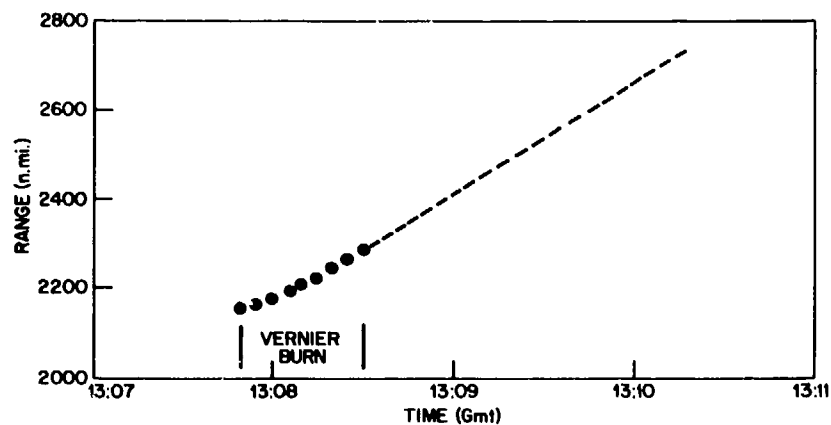


Fig. 8 — Plot of range versus time for the burning vernier stage

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Table 2
Velocity Estimates During Vernier-Engine Burn
(With Shutdown at 13:08:22)

Time (GMT)	Range (n.mi.)	Velocity (knots)
13:07:50	2150	7390
13:07:55	2163	7840
13:08:00	2173	11125
13:08:06	2191	10080
13:08:10	2203	12950
13:08:15	2222	13650
13:08:21	2245	15100
13:08:26	2266	15120
13:08:30	2282	15120

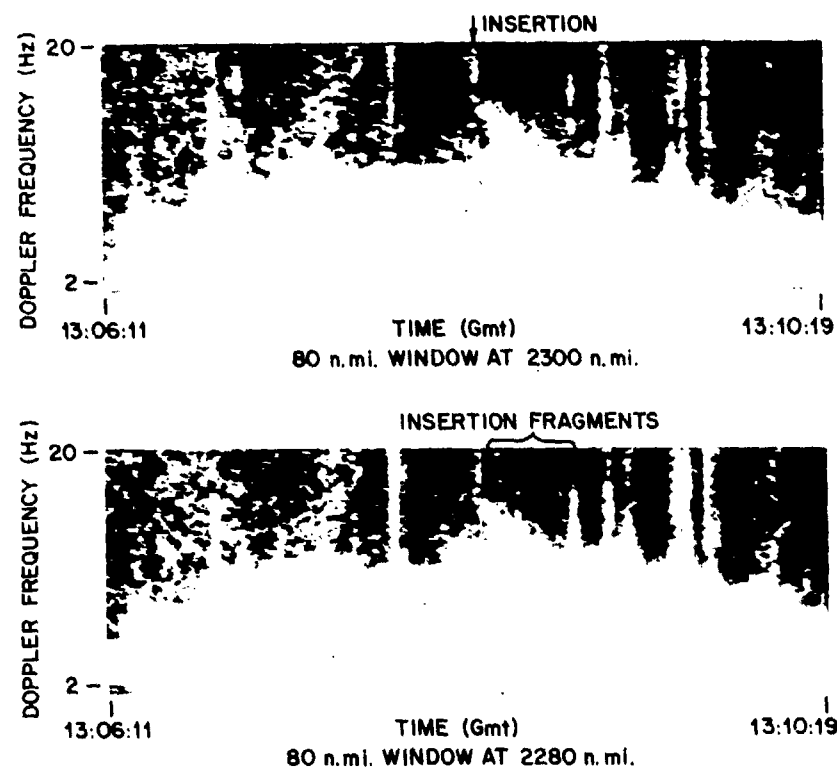


Fig. 9 — Doppler-versus-time record showing insertion fragments
for two range samples

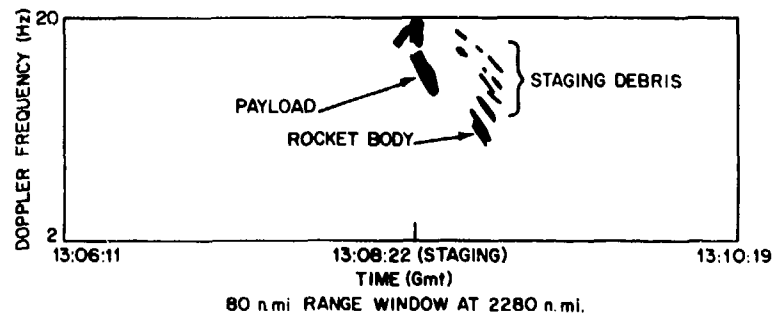


Fig. 10 — Doppler-versus-time record showing echoes from multiple scatterers at insertion-staging time

16 to 20 seconds. If echoes stay appreciably longer in a given range window (unless due to multimode mechanisms), they are likely not to be associated with the hypervelocity satellite vehicle and its vernier-stage rocket body.

(S) Both frames of Fig. 9 are rather noisy. Intensity has been raised purposely to reveal weak echoes in the lower frame to the right of (at later time than) "insertion." The large echo that seems to emerge from the lower doppler background, to the right of the insertion point with slope down to the right is believed to be the payload and/or vernier rocket body.

(S) The insertion fragments have been redrawn in Fig. 10. Those elements believed to be the payload and/or rocket body are so labeled. Other pieces lacking even tentative identification are labeled staging debris. Efforts are still being made to identify other pieces of the Cosmos 478 insertion-staging debris.

(S) Cross-section measurements of the separation elements have not been made. The vernier-engine-burn echo appeared to be approximately 10^4 square meters.

LONG-RANGE AIRCRAFT DETECTIONS

(S) Figure 11 is a doppler-versus-range display for the time 13:01:17. A 5-second integration period was in use. The aircraft that is on doppler and range strobes as well as one at a lower doppler at about the same range and a third aircraft with weaker signal strength at a slightly longer range and higher doppler frequency are being illuminated by second-refraction energy. Other aircraft under one-hop illumination are in view at longer ranges (actually shorter ranges, inasmuch as the 915-n.mi. target is at 2915 n.mi.).

(S) Figure 12 is a range-versus-time plot showing tracking developed for the three aircraft targets of Fig. 11 at ranges in excess of 2900 n.mi. The length of tracks was constrained by available tape. Each of the three tracks was obscured by the perturbation signal shortly after 13:06:30. At least one of these aircraft however is visible in Fig. 4 after the perturbation-echo doppler width contracts at approximately 13:13:00.

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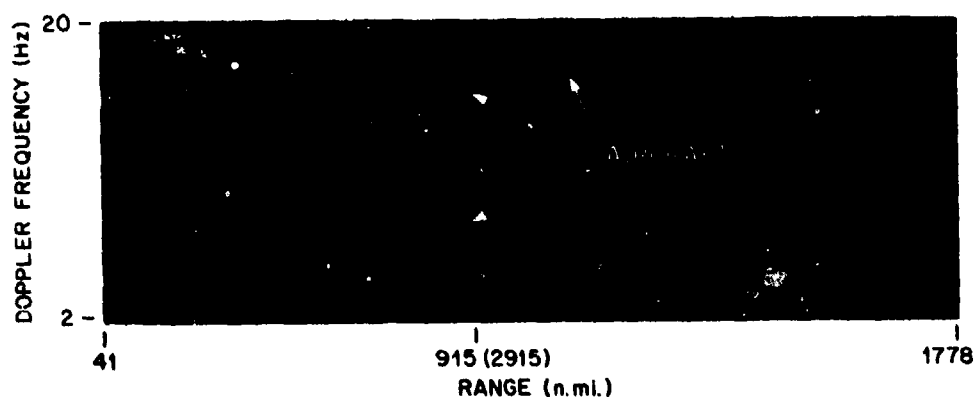


Fig. 11 -- Doppler-versus-range record for 13:01:17 GMT

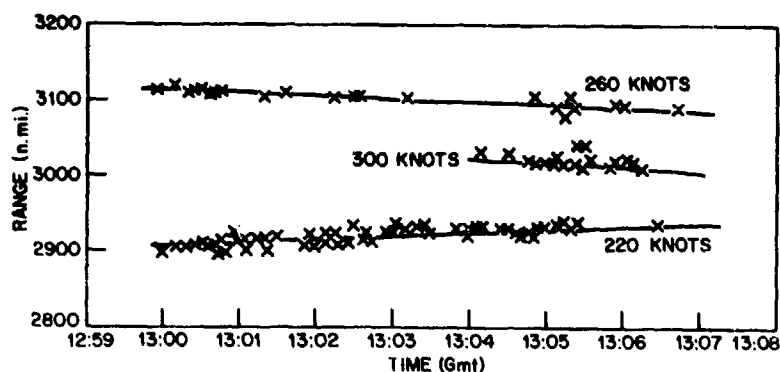


Fig. 12 -- Range-versus-time plot of long-range aircraft

CONCLUSIONS

(S) That the FPS-95 radar can see weak targets at extended OTH range is appropriately demonstrated in this reporting. The signal-to-noise ratio (S/N) was good to excellent for the perturbation, vernier-burn, and >2900-n.mi. aircraft echoes. S/N as determined to date for the insertion-staging elements has been moderate to poor.

(S) The Madre radar has not detected 3000-n.mi. aircraft as well as those detected by the FPS-95 radar and reported here. Neither has the Madre system detected the unwrapping of a spacecraft at orbital insertion time. The detection of the insertion staging is a notable achievement for the FPS-95 radar. It is highly probable that the FPS-95 radar will prove itself to be a unique sensor permitting the discrimination and cataloging of various target signatures heretofore not possible.

(S) The NRL mission of analyzing, evaluating, and interpreting FPS-95 data in support of the U.S. Air Force program has indeed been exciting. It is anticipated that in the near

future the capability will be available to use the NRL wide-dynamic-range (>100 dB) analog acceleration processor on FPS-95 missile tapes.

(S) The authors of this report welcome the opportunity to participate in the establishment of detection credibilities for the FPS-95 for all man-made targets. It is anticipated that FPS-95 radar sensitivity will permit the detection and identification of missiles, aircraft, ships, trains, and vehicular traffic along heavily traveled roadways.

REFERENCES

1. J.M. Headrick, "Madre Detection of Aircraft and Missiles Using Narrow-Band Spectrum Analysis After Backscatter Rejection," Proceedings of the ARPA Meeting of 17 Oct. 1961 (Secret).
2. J.M. Headrick, "Madre Observations of Aircraft and Missiles," Proceedings of the ARPA meeting of 15 Feb. 1962 (Secret).
3. G.A. Skaggs, C.B. Tesauro, and F.H. Utley, "Reentry Phenomena Observed Using High-Frequency Radar," NRL Report 6507 (Secret report, Unclassified title), Feb. 10, 1967.
4. J.R. Davis, M.E. Harding, J.W. Willis, and F.H. Utley, "Applications of Computer-Aided Ionospheric Ray Tracing Techniques to the Analysis of Over-the-Horizon Radar Signatures from Launch-Phase Rockets," NRL Report 6731 (Secret report, Unclassified title), July 30, 1968.
5. J.M. Headrick, B.N. Navid, J.L. Ahearn, S.R. Curley, F.H. Utley, W.C. Headrick, and E.N. Zettle, "Madre ICBM Detection," NRL Memorandum Report 1251 (Secret report, Unclassified title), Dec. 1, 1961.
6. J.M. Headrick, E.W. Ward, and D.L. Lucas, "Information on OTH Radar, Part XII—Missile Detection at Altitude for a Medium Distance," NRL Memorandum Report 1758 (Secret report, Unclassified title), Feb. 1967.
7. F.H. Utley, C.B. Tesauro, J.M. Headrick, W.C. Headrick, F.E. Wyman, and R.J. Schweitzer, "HF Radar Signatures," NRL Memorandum Report 1939 of October 1968 (Secret report, Unclassified title).
8. F.H. Utley, C.B. Tesauro, J.M. Headrick, W.C. Headrick, F.E. Wyman, and R.J. Schweitzer, "Sprint Missile Signatures," Proceedings of the ARPA Meeting 23-25 October 1968 (Secret report, Unclassified title), Nov. 1968.
9. J.L. Ahearn, W.C. Headrick, J.M. Headrick, C.B. Tesauro, and E.N. Zettle, "Extended-Range Aircraft Tracking," NRL Report 6272 (Secret report, Unclassified title), May 12, 1965.
10. J.R. Davis, J.F. Thomason, J.M. Hudnall, F.E. Boyd, and F.H. Utley, "The Spectral Characteristics and Temporal Behavior of HF Radar Echoes from Over-the-Horizon Aircraft Targets," NRL Report 6371 (Secret report, Unclassified title), Nov. 18, 1965.
11. F.H. Utley, W.C. Headrick, F.E. Wyman, D.C. Rohlf, and J.F. Thomason, "Over-the-Horizon Detection of Multiple Aircraft," NRL Report 7044 (Secret report, Unclassified title), Feb. 20, 1970.

SECRET

NRL REPORT 7692

12. F.H. Utley, W.C. Headrick, J.F. Thomason, and F.C. Chambers, "Surveillance Potential of an HF Radar," NRL Report 7350 (Secret report, Unclassified title), Dec. 1, 1971.
13. J.R. Barnum, "'Ship Ahoy' Summary Through March 1972," Stanford Research Institute Technical Report 17 (Secret report, Unclassified title), Aug. 1972.
14. J.L. Ahearn, "Ship Detections," Proceedings of May Bell Technical Workshop of 18-22 May 1970 sponsored by ARPA (Secret report, Unclassified title).
15. Personal communication from Joe Thomason at Orfordness, U.K.
16. C.L. Uniacke, G.K. Jensen, C.B. Tesauro, and J.H. Veeder, "A Study of Ionosphere Disturbances with the Project Music Radar - 1 September 1957 to 31 May 1959," NRL Report 5508 (Secret report, Unclassified title), Aug. 8, 1960.
17. C.L. Uniacke, G.K. Jensen, and J.H. Veeder, "A Study of Ionospheric Disturbances with the Project Music Radar - 1 June 1959 to 31 October 1959," NRL Report 5511 (Secret report, Unclassified title), Aug. 19, 1960.
18. C.L. Uniacke, G.K. Jensen, and J. H. Veeder, "A Study of Ionospheric Disturbances with the Project Music Radar from 1 November 1959 to 31 January 1960," NRL Report 5564 (Secret report, Unclassified title), Dec. 6, 1960.
19. C.L. Uniacke, G.K. Jensen, and J.H. Veeder, "A Study of Ionospheric Disturbances with the Project Music Radar from 1 February 1960 to 30 June 1960," NRL Report 5584 (Secret report, Unclassified title), Feb. 10, 1961.

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MEMORANDUM

20 February 1997

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1. In Enclosure (a) it was recommended that the following reports be declassified, four reports have been added to the original list:

Formal: 5589, 5811, 5824, 5825, 5849, 5862, 5875, 5881, 5903, 5962, 6015, 6079, 6148, 6198, 6272, 6371, 6476, 6479, 6485, 6507, 6508, 6568, 6590, 6611, 6731, 6866, 7044, 7051, 7059, 7350, 7428, 7500, 7638, 7655. Add 7684, 7692.

Memo: 1251, 1287, 1316, 1422, [REDACTED], 1500, 1527, 1537, 1540, 1567, 1637, 1647, 1727, 1758, 1787, 1789, 1790, 1811, 1817, 1823, 1885, 1939, 1981, 2135, 2624, 2701, 2645, 2721, 2722, 2723, 2766. Add 2265, 2715.

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2. The above reports are included in the listings of enclosures (b) and (c) and were selected because of familiarity with the contents. The rest of these documents very likely should receive the same treatment.

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